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Analysis of patients with pleural effusion who underwent surgery

Pleural effusion

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Abstract

Aim: Pleural effusion develops due to an imbalance between the formation of pleural fluid and reabsorption cycle. In this study, we aim is to discuss the results of patients with pleural effusion treated by surgical methods.

Material and Methods: Three hundred forty-five patients were analyzed. Patients were divided into 10 groups as etiological, and two groups according to the treatment procedures. The statistical significance of gender, location of the disease, underlying diseases, and the treatment of the patients were evaluated. The significance of the results was assessed by the Chi-square test or the Fisher's exact test. $P < 0.05$ was considered significant.

Results: In empyema, right hemithorax location and exudative property were found to be significant. In congestive heart failure, male gender, left hemithorax localization and being transudative were found to be statistically significant. In malignant mesothelioma, male gender, right hemithorax location, and being exudative were statistically significant. In parapneumonic effusion, right hemithorax location and exudative property were found to be significant. In cirrhosis, female gender, right hemithorax location and being transudative were significant. In tuberculosis, being exudative was found to be significant. In paramalignant pleural effusion, exudative property was found to be significant. In pleural metastasis, male gender and being exudative were found to be statistically significant. During the treatment, tube thoracostomy was statistically significant in patients with congestive heart failure, parapneumonic effusion, pleural metastasis, cirrhosis, and undiagnosed diseases.

Discussion: Pleural effusions can be managed according to the underlying diseases. Tube thoracostomy is the main method for the treatment of pleural effusions.

Keywords

Pleural Effusion; Thoracostomy; Thoracotomy; Thoracoscopy

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Introduction

Under normal conditions,the spacebetween the two pleura contains 0.1-0.2 ml/kg fluid. This means that each hemithorax has 10-15 ml of pleural fluid. Pleural effusion develops due to an imbalance between the formation of pleural fluid and reabsorption cycle. This balance can be disrupted by various mechanisms [1-11]. While malignant cells are seen in pleural fluid in malignant pleural effusions, they are not available in effusion even if cancer exists in some cases. Such pleural effusions are called as paramalign pleural effusions [12]. Symptoms are related to the amount of accumulated liquid [1]. The chest X-ray is the first diagnostic imaging method in the evaluation of pleura [13].

In this study, we aim is to discuss the results of patients with pleural effusion treated by surgical methods in the literature.

Material and Methods

Patients

Three hundred forty-five patients with pleural effusion surgically treated within ten years were analyzed retrospectively. All patients provided written informed consent and the study was approved by Dicle University, Medical School Ethical Committee.

Study design

Patients were divided into 10 groups as patients with empyema, congestive heart failure (CHF), chronic renal failure (CRF), malignant mesothelioma (MM), paramalignant pleural effusion (PMPE), parapneumonic effusion (PPE), pleural metastasis (PM), cirrhosis, tuberculosis (TBC) and undiagnosed patients. The age, sex, symptoms, vital signs, laboratory findings (leukocyte (WBC), hemoglobin (HB), hematocrit (HTC), sedimentation, total protein (TP), albumin (ALB), transudate, exudate), pre-existing (underlying) diseases, the location of disease (in patients with bilateral pleural effusion, the part treated surgically was taken into consideration), diagnostic procedures, surgery methods performed on patients (method which worked well was taken into account), complications and hospitalization periods of all patients and patients in each group were identified. Mortality and morbidity rates among patients were examined. Patients were divided into two groups according to the treatment type performed under local or general anesthesia. The statistical significance of gender, location of the disease, underlying diseases, and the treatment of the patients were evaluated. Data of the patients were assessed through the hospital's medical records review.

Inclusion and exclusion criteria

Patients treated with surgery procedures were evaluated. Pleural effusion patients who were not treated with surgical procedures consulted by us and receivedsuggestions from us in the emergency room, outpatient clinics or other services were excluded.

Statistical analysis

In statistical analysis, continuous variables were expressed as mean ± standard deviation, and categorical variables were explained as number ratio. The significance of the results was assessed by the Chi-square test or the Fisher's exact test. $P<0.05$ was considered significant.

Table 1. Distributions of patients with pleural Effusion

Diseases	M	F	P	R	L	P	Age	T	E	P
Empyema	15	19	0.4672	24	10	0.0014	32.26	0	34	0.0001
Chf	37	22	0.0097	19	40	0.0002	57.18	51	8	0.0001
Crf	-	1	1.0000	1	-	1.0000	44.00	1	0	1.0000
Mm	44	21	0.0001	39	26	0.0349	55.47	0	65	0.0001
Pmpe	18	10	0.1144	16	12	0.4230	54.53	0	28	0.0001
Ppe	27	18	0.0912	32	13	0.0001	28.75	13	32	0.0001
Pm	27	14	0.0077	24	17	0.1848	52.80	7	34	0.0001
Cirrhosis	-	8	0.0002	8	-	0.0002	55.37	8	0	0.0002
Tbc	17	11	0.1810	17	11	0.1810	30.28	0	28	0.0001
Undiagnosed	28	8	0.0001	26	10	0.0003	26.60	3	33	0.0001
Total	213	132	0.0001	206	136	0.0001	44.31	83	262	0.0001

Chf: Congestive heart failure, Crf: Chronic renal failure, Mm: Malignant mesothelioma, Pmpe: Paramalignant pleural effusion, Ppe: Parapneumonic effusion, Pm: Pleural metastasis, Tbc: Tuberculosis, M: Male, F: Female, R: Right, L: Left, T: Transudate, E: Exudate, P: P value

Results

The average age of patients was 44.51 ± 8.20 years. Additionally, 213 (62%) were male and 132 (38%) were female. The disease was on the right side in 206 (60%) of the patients, whereas it was on the left in 139 (40%). Eighty-three (24%) of effusions were transudative, 262 (76%) were exudative. It was found to be significant in terms of pleural effusion occurring in male gender, the localization of right hemithorax and fluid having exudative features (p: 0.0001). Of the patients divided into ten groups, 34 (10%) had empyema, 59 (17%) had CHF, 1 (1%) had CRF, 65 (19%) had MM, 28 of them (8%) got PMPE, 45 (13%) had PPE, 41 of (12%) had PM, 8 (2%) had cirrhosis, 28 of them (8%) were diagnosed TBC, and 36 (10%) were undiagnosed patients (Table 1).

In the laboratory examinations of patients, average WBC was found to be 7595.36 ± 4111.57, HB was 11.35 ± 1.71, HTC was 35.34 ± 4:54, Sedim was 36.02 ± 16:21, TP was 6.5 ± 1.12, and ALB was 3.6 ± 0.82. The highest WBC value was 12261 for empyema, while the lowest was in cirrhosis (3775). The highest HB value was 13.06 in PPE, whereas the lowest one was in the CRF (8). Moreover, the highest HTC value was 39.64 in TBC, while the lowest was in CRF (28). The highest SEDIM value was in PMPE (46.25), the lowest one was in CRF (20). The highest TP value was in TBC (7.8), whereas the lowest pin was in PMPE (5.6), In addition, the highest ALB value was in TBC (4.2), while the lowest was in cirrhosis (2.4).

The mean age of the patients with empyema (n = 34) was 32.26 years. Fifteen of the patients were male (44%), and 19 (56%) were female. Effusion was on the right in 24 patients (71%), while it was on the left in 10 patients (29%). In these patients, the location of right hemithorax (p: 0.0014), and exudative property (p: 0.0001) were found to be significant. The mean age of the patients with CHF (n = 59) was 57.18. Additionally, 37 (63%) were male and 22 (37%) were female. In 19 patients, effusion was on the right (32%), whereas in 40 patients it was on the left (68%). Fifty-one (86%) of effusions were transudative, while 8 (14%) was characterized as an exudative. In CHF-induced pleural effusions, male gender (p: 0.009), localization of left hemithorax and being transudative (p: 1.000) were found to be statistically significant. The patient with CRF was female and 44 years old. Effusion was on the right hemithorax and had transudative features. Gender, localization and being transudative was not significant in CRF-induced pleural effusion. The mean age of the patients with MM (n:65) was 55.47 years. Forty-four (%68) of the patients were male and 21(%32) were female. Effusion was on the right (%60) in 39 patients, whereas it was on the left in 26 of the patients (%40). All of the fluid was exudative. In MM-induced pleural effusion, male gender (p: 0.0001), right hemithorax location (p: 0.0349), and being exudative (p: 0.0001) were statistically significant. The mean age of the patients with PPE was 28.75 years (n:45). In addition, 27 (%60) were male, 18 (%40) were female. Effusion was on the right in 32 of the patients (%71), whereas it was on the left in 13 (%29). Furthermore, 13 (%29) of the effusions were transudative, while 32 (%71) had exudative property. In PPE-induced pleural effusions, right hemithorax location (p: 0.0001) and exudative property were found to be significant. The mean age of the patients with cirrhosis was 55.37 years (n:8). All of the patients were female (n:8, %100). Effusion had right localization and transudative property. In cirrhosis-induced

Table 2. Concomitant diseases in patients with PMPE and PM

Concomitant diseases	PMPE	PM	Total	P value
Lung cancer	3	11	14	0.0070
Breast cancer	8	10	18	0.7395
Larynx cancer	3	2	5	1.0000
Chondrosarcoma	-	4	4	0.0286
Osteosarcoma	-	3	3	0.1000
Pancreatic cancer	5	2	7	0.2861
Surrenal cancer	5	2	7	0.2861
Liver cancer	1	6	7	0.0291
Colon cancer	-	1	1	1.0000
Prostate cancer	3	-	3	0.1000

PMPE: Paramalignant pleural effusion, PM: Pleural metastasis

Table 3. Treatments procedures of patients with pleural effusion

Diseases	LA	GA		P	Strept.	Pleuro.
	TT	Thoracotomy	Thoracoscopy			
Empyema	17	13	4	1.0000	6	0
Chf	59	-	-	0.0001	0	10
Crf	1	-	-	1.0000	0	0
Mm	32	11	22	1.0000	2	37
Pmpe	11	-	15	0.1810	5	24
Ppe	42	-	3	0.0001	1	0
Pm	39	-	-	0.0001	0	25
Cirrhosis	8	-	-	0.0002	0	0
Tbc	10	-	18	0.0604	0	0
Undiagnosed	36	-	-	0.0001	0	0
Total	255	26	64	0.0001	14	96

Chf: Congestive heart failure, Crf: Chronic renal failure, Mm: Malignant mesothelioma, Pmpe: Paramalignant pleural effusion, Ppe: Parapneumonic effusion, Pm: Pleural metastasis, Tbc: Tuberculosis, Strept: Streptokinase, Pleuro: Pleurodesis, LA Local anesthesia, GA: general anesthesia, TT: Tube thoracostomy

pleural effusions, female gender, right hemithorax and being transudative were significant (p: 0.0002). The mean age of the patients with TBC was 30.28 (n:28). Seventeen (%61) of the patients were male, while 11 (%39) were female. Effusion was on the right in 17 (%61) of the patients, whereas it was on the left in 11 (%39). All fluid had exudative property. In TBC induced pleural effusions, being exudative was found to be significant (p: 0.0001). The mean age of undiagnosed patients was 26.60 years (n:36). Moreover, 28 (%78) of the patients were male, while 11 (%22) were female. Effusion was on the left in 26 (%72) of the patients, whereas it was on the right in 10 (%28). Three (%8) of the effusions were transudative, while 33 (%92) were exudative. In this group, male gender (p: 0.0001), right hemithorax location (p: 0.0003), and exudative property (p: 0.0001) were found to be statistically significant (Table 1).

The mean age of the patients with PMPE (n:28) was 54.53 years. Moreover, 18 (%6) of the patients were male, while 10 (%32) were female. Effusion was on the right in 16 (%57) of the patients, while it was on the left in 12 (%43). All fluid was exudative. In patients with PMPE, exudative property of the fluid was found to be significant (p: 0.0001). It was discovered that 3 patients (11%) had lung cancer, 8 (28%) had breast cancer, 3 (11%) had prostate cancer, 3 (11%) had larynx cancer, 5 (18%) had pancreatic cancer, 1 (3%) had liver cancer, and 5 (18%) had surrenal cancer. The mean age of the patients with PM was 52.8 years (n: 41). Additionally, 27 were male (%66), and 14 (%34) were female. Effusion was on the right in 24 of the patients (%59), while it was on the left in 17 (%41) patients. Seven of the effusions were transudative, whereas 34 (%83) were exudative. In PM-induced pleural effusions, male gender (p: 0.007) and being exudative (p: 0.0001) were found to be statistically significant. The most common accompanying malignancy was breast cancer in patients with PME, but lung cancer in patients with PM. In pleural metastasis, induced pleural effusion, lung cancer, chondrosarcoma, and liver cancer were found to be statistically significant in the development of effusion (respectively p: 0.007, 0.028, 0.029) (Table 1, 2).

The most common symptoms were shortness of breath, chest pain, and cough. It was found that the first diagnostic method used was chest radiography, the second one was computed tomography. Thoracic ultrasound was another method that was used less frequently.

During the treatment, it was identified that 255 (74%) of the patients with pleural effusion underwent tube thoracostomy (under local anesthesia) and 90 (26%) underwent thoracotomy/ thoracoscopic surgery (under general anesthesia). Surgeries performed under local anesthesia (tube thoracostomy) were statistically significant in the treatment of patients with CHF, PPE, PM (p: 0.0001), cirrhosis (p: 0.0002) and undiagnosed diseases (p: 0.0001). However, they were not significant in the treatment of patients with empyema (p: 1.00), CRF (p: 1.00), MM (p: 1.00), PMPE (p: 0.18) and TBC (p: 0.06). In addition, it was found that 14 (4%) of the patients with the effusion were given streptokinase (empyema: 6, MM: 2, PMPE: 5, PPE: 1), 96 (28%) were applied pleurodesis (CHF: 10, MM: 37, PMPE: 24, PM: 25) (Table 3). The most common complications were expansion defects and atelectasis. The mortality rate was 1.15% (n = 4). Two (18%) of the patients who died suffered from lung with PM, 1 (50%) suffered from larynx with PM and 1 (50%) suffered from the surrenal ca with PM. The average length of stay of patients was 6 ± 4 days.

Discussion

The main reason for pleural effusion is the deterioration of the balance between microvascular hydrostatic-oncotic pressure in the parietal and visceral pleura and lymphatic drainage capacity [1]. Although it is equally seen in both genders, distribution of genders may vary depending on the etiology. It has been reported that 2/3 of the malignant pleural effusions related to breast and gynecological reasons are seen in females, whereas effusions related to MM and pancreatitis are more frequent in males [8, 9]. In our study, there was a male predominance in patients with pleural effusion and male gender was found to be significant in the development of pleural effusion.

In the study by Tunçozgur et al. [14] with 97 parapneumonic effusion and 42 empyema cases, it was reported that 62% of the patients were male and the mean age was 34. Additionally, Mihmanli et al. [15] claimed that tuberculous pleurisy is more common in the 30-35 age and in male gender, and effusions accompanying malignant diseases are generally encountered over age 50 [16]. In our study, 60% of patients with PPE were male and the average age was 28.75. In addition, %56 female gender and 32,26 age ratio were found for the patients with empyema.

Transudate is low protein fluid and occurs due to the imbalance between the hydrostatic and oncotic power or lymphatic obstruction. Exudate occurs due to permeability increase in the pleural surface and microvascular structures. Their protein content is high. Pleural fluid having exudative or transudative property varies depending on the underlying disease [6]. In our study, the exudate rate was %76.

The most common causes of pleural effusion are CHF, bacterial pneumonia, lung cancer and lymphoma. The most common causes of malignant pleural effusion in Turkey are lung cancer, MM, and breast cancer. It has been reported that females mostly have breast, gynecologic, and lung cancers, while male patients have lung, lymphoma, gastrointestinal cancers. In addition, It was suggested that all transudates are CHF, pulmonary embolism, and cirrhosis, while exudates are pneumonia (%90), malignant diseases, and pulmonary embolism and gastrointestinal disorders [2, 17]. The most common causes of effusion in our study were MM (65%) and CHF (59%).

Congestive heart failure has been reported as the most common cause of pleural effusion. It is 60% bilateral and does not exceed 1/3 of hemithorax. They are mostly transudative. They may also be exudative due to diuretic therapy [4]. In our study, the rate of pleural effusions due to CHF was 17%. Male gender, location of left hemithorax, and character of transudate were found to be significant in patients with CHF associated pleural effusions. The reason why cases with left hemithorax were focused can be explained by the fact that the patients participated in the study were the patients who only underwent the operation.

In cirrhotic patients, pleural effusion develops by 6%. It is right-sided and transudative by 80%. It has been reported that fluid passes to hemithorax through diaphragmatic pores due to the

negative pressure in the chest. Pleurodesis is not recommended because it develops very quickly [5]. In our study, the percentage of pleural effusion due to cirrhosis was 2%. Female gender, right hemithorax, and transudative property were significant for the patients with pleural effusion related to cirrhosis.

Parapneumonic effusion constitutes 50-75% of pleural effusion. Effusion develops in 20% of patients with pneumonia; 40% of them become empyema [18]. In our study, PPE constituted 13% of the effusions, and empyema constituted 10%. In both PPE and empyema, right hemithorax location and transudative property were found to be significant.

Pleural effusion develops in 20% of patients with CRF. It is often characterized as bilateral and transudative. TBC pleurisy occurs with hypersensitivity reaction consisting of bacilli that enters into the pleural space or the bacilli reaching the pleural cavity through lymphatic or hematogenous means. The fluid is usually one-sided. The diagnosis is confirmed by biochemical and pleural biopsy [19]. In this study, TBC pleurisies constituted 10% of the effusions. Additionally, effusion was more common in male gender, was on the right side, and had exudative property. Gender and right hemithorax location were not significant in TBC pleurisy, whereas exudative property was significant in TBC pleurisy.

Malignant pleural effusion is common in cancer patients. In theory, even if malignant pleural effusion can develop in all types of cancer, it mainly develops in lung cancer in male gender, and in breast cancer in female gender. Even if some patients develop cancer, malignant cells may not be available in developing effusion. These effusions are called as PPE. Only 60% of the patients with PM develop pleural effusion [8, 9, 10, 20]. In our study, effusion with PM constituted %41 of the effusions, whereas PME constituted %28 of them. Both PMPE and PM were mostly seen in males and was in right hemithorax, and exudative. The most common concomitant malignancy was lung cancer.

Malignant mesothelioma is a primary pleural tumor, which presents in the 5th and 7th decades of life, and common in male gender. It is divided into 3 types as epithelial, sarcomatoid, and mixed. The most commonly seen type is epithelial, while the least frequent one is sarcomatiod. It often causes one-sided pleural effusion and thickening. The diagnosis is made by biopsy of the pleura. During the surgical treatment, radiotherapy, and chemotherapy can be used separately or together [21, 22, 23]. In our study, MM induced pleural effusions constituted 19% of the effusions. Male gender and right hemithorax location and exudative property were available. For MM induced effusions, male gender, right hemithorax, and exudative property were found to be significant.

The undiagnosed group constituted about 10% of all pleural effusions. In this group, male gender dominance was present at the right hemithorax, and fluid was exudative. For this group, male gender, right hemithorax location, and exudative property were significant.

The most common symptom of pleural effusion is dyspnea. In addition, cough is slight and nonproductive. Chest pain may be sharp penetrative or blunt type. Pain increases with deep inspiration. Weight loss, fever, hemoptysis can be added to the table [1, 6]. In diagnosis, chest X-ray, ultrasound, computed tomography are the primary diagnostic methods [13].

For the treatment of pleural effusions, thoracentesis, tube thoracostomy, fibrinolytics, removal of adhesions by thoracoscopy or thoracotomy and open drainage through decortication are methods commonly used [24]. In this study, 255 of (74%) patients with pleural effusion underwent tube thoracostomy (under local anesthesia), 90 (26%) (thoracotomy: 26, thoracoscopic surgery: 64) patients with pleural effusion underwent thoracotomy/thoracoscopic surgery (under general anesthesia). It was understood that surgeries performed under local anesthesia were significant in the treatment of patients with effusion. Surgeries performed under local anesthesia were found to be significant in the treatment of patients with CHF, PPE, PM, cirrhosis and undiagnosed patients. Yet, they were not statistically significant in the treatment of the patients with empyema, CRF, MM, PM and TBC. Additionally, it was discovered that 14 patients (4%) were given streptokinase, and 96 (28%) were performed pleurodesis. The presence of malignant cells in pleural fluid indicates the poor prognosis and the average survival of 4-6 months [8, 9]. In our study, mortality rate was 1.15% (n = 4). All of these patients had pleural metastasis.

As a result, pleural effusions may be caused by many diseases. Moreover, the treatment of pleural effusion can be planned and managed according to the underlying diseases. The data obtained from the effusion may vary according to the location of the underlying disease. Although, tube thoracostomy is the main method for the treatment of pleural effusions, thoracotomy and thoracoscopic surgery can be preferred for the diagnosis and treatment.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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